

# **PEDAGOGICAL AND PARENTAL INFLUENCES IN MATHEMATICS ACHIEVEMENT BY GENDER AMONG SELECT EUROPEAN COUNTRIES FROM THE TIMSS-R STUDY**

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## **Abstract**

Utilizing the top three scoring European countries in mathematics achievement from the TIMSS-R Study, the researchers sought to identify specific parental and pedagogical variables that contribute to high mathematics achievement. These predictor variables were also analyzed by commonalities and disparities by country and gender. This study extracted data from approximately 12,000 eighth-grade students from Belgium-Flemish, Netherlands, and Slovak Republic. The results disclosed for both genders in all three countries that student self-concept in mathematics was the strongest predictor of high mathematics achievement. Additional significant positive predictors for both males and females in all three countries include a positive attitude towards mathematics and home educational resources. Pedagogical and parental factors were also key influences to high mathematics achievement. Majority of the students reported that at least one of their parents attended and/or completed a university program and they had an ample supply of reference books in their home. In addition, their teachers stressed critical thinking and problem solving skills in the classroom. Both genders within all three countries evinced negative significance with respect to owning or having access to all three educational aids (a computer, a personal study desk, and a dictionary) in their home. In addition, general outside-study time was not significant for both genders in Belgium-Flemish and the Netherlands and negatively significant in Slovakia. Student reports on hours spent studying mathematics or doing mathematics homework was not significant for both genders in the Netherlands and male students in Belgium-Flemish; however, both genders in Slovakia and female students in Belgium-Flemish evinced negative significance, which implies that these students do not complete tasks involving their mathematical assignments outside of school. Although negligible differences were found by gender within all three countries on the mathematics achievement tests, the number of females entering the

university and majoring in mathematics is low and in sharp contrast to males. Thus this study supports the need to investigate additional social and environmental variables that result in limited female participation in the hard sciences at the university level.

## **INTRODUCTION**

The proliferation of technology-based economies within the past two decades has propelled governmental agencies throughout Europe into reevaluating the quality of their national educational curriculums. In addition to implementing standards and initiatives that equip students with "information age" skills, vanguards of educational reform continue to seek the configuration of educational and psychological variables that produce high achieving students in the patent-based disciplines as they are integral to economic competitiveness and military survival in the global age.

One of the most recent assessments on international mathematics achievement at the eighth grade level is the Third International Mathematics and Science Study-Repeat (TIMSS-R), 1999, conducted by the IAE (Mullis, Martin, Gonzalez, Smith, Chrostowski, Garden, & O'Connor, 2000). Thirty-eight nations elected to participate in the TIMSS-R (1999); in which twenty-three of these nations participated in the TIMSS 1995 assessment. In both the 1995 and 1997 assessments, the top scoring European nations, Belgium- Flemish, Netherlands, and Slovakia, trailed right behind the top scoring countries - all located in the Eastern Hemisphere. Precluding geographic propinquity, each of these European countries, like the top scoring Asian countries, share the phenomena of gender inequities in female participation in the technical sciences. This is of particular importance to technology-based economies as a dearth of female mathematicians and scientists exist worldwide and global economic success necessitates the proliferation of mathematically precocious students.

The objectives of this study were: 1. To identify specific parental and pedagogical influences that contribute to male and female's mathematics achievement in Belgium-Flemish, Netherlands, and Slovak Republic; 2. To investigate the students' perceptions of their ability to solve mathematical problems and their attitude towards mathematics; 3. To determine the structural linkages between the amount of time students devote to scholastic work (both general and mathematical) outside of school; 4. To determine the structural linkages among mathematics self-concept and achievement; and 5. To identify various social and environmental factors that contribute to gender disparities in mathematics achievement.

## **REVIEW OF LITERATURE**

Theoretical frameworks used to analyze motivational and environmental variables are Walberg's Educational Productivity Model (1984), The Dweck Implicit Theories Model on Intelligence (1986), and Campbell's Differential Socialization Paradigm (1994).

Wang, Heartel and Walberg (1993) identify the home environment as a major causal influence to student learning. Although the home environment comprises several

motivational variables, the most salient involve the parents (Bandura, 1997; Chao, 2001; Eccles & Harold, 1993; Walberg, 1984). Research concurs that parent(s) provide psychological support and cognitive stimulation (Brutsaert, 1999; Eccles & Harold, 1993; Nash, 1997; Zirpoli, & Melloy, 2000) and influence the quality and level of educational resources within the home (Campbell & Wu, 1994) which are critical to effective student learning. Collins, Maccoby, Steinberg, Hetherington, and Bornstein (2000) found that adolescents who perceived their parents as authoritative (demanding but responsive and democratic) were more likely to do well in school.

Brutsaert's (1998; 1999) research with Belgium coeducation schools evinced high student academic achievement when the students perceived their parents as supportive, inquired about grades, and attended school meetings. Parental input into curricula decisions throughout Europe however, have remained modest (Kallen, 1996). De Jong, Westerhof, & Creemers (2000) found that parents of low achieving students in the Netherlands may influence the amount of homework time, but overall are not a significant factor in terms of homework.

In the pursuit of quality pedagogy and student achievement in higher education, educational institutions throughout Europe have been given some degree of autonomy and have thus undergone curricular transitions (Kallen, 1996; Maasen, 1997). Since the mid 1980's, formal assessment of teaching programs has been implemented in the Netherlands, followed by Denmark and Flanders (Massen, 1997). Stakeholders have changed, and formalized "systematic quality assessment procedures" have been implemented. Emphasis has been placed on the quality of the activities of the institution and staff. Once the primary responsibility of the national governments, stakeholders now include members from institutions of higher education, corporate employers of graduates, politicians (Maasen, 1997), church officials, parents, and pupils (Kallen, 1996). Similar to the accrediting agencies in the United States (Galluzzo, 1999), European national educational institutions must provide formative and summative proof that they are providing quality education.

In the pursuit of optimum student performance, Belgium and the Netherlands have profoundly reformed the curricula of lower secondary education (Kallen, 1996; Soetart & VanHeule, 1996). Among the Central European countries, Slovakia has invested significantly in teacher training, textbooks, teaching and learning aids and materials (Nagy, 1998). In addition, several European educational systems are linking mathematics education with national pride. The Slovakian schools promote the concept of education being linked to personal well-being and national unity (Kallen, 1996), as common social and societal realities formulate the basis for a value-based system that fosters academic achievement (Schiering, 2003). Slovakia's strong emphasis on acquisition of mathematics proficiency is evinced in "The 1993 Education Act" where secondary students are mandated to attend a preparatory program that encourages mathematics content (Temple, 1997).

In the Netherlands, many teachers and textbook authors have adopted the Realistic Mathematics Education (RME) Approach in the primary and secondary teaching of mathematics. The RME Approach emphasizes active participation in real world applications, with a focus on problem solving skills, integrating models, and

representing relations in formulas (Treffers, 1993; Van den Heuvel-Panhuizen, 2000). The RME approach has been implemented into the mathematics curriculum in several European and Asian countries, Germany, Denmark, Spain, England, Japan, and Malaysia and select school districts within the United States (Treffers, 1993; Van den Heuvel-Panhuizen, 2000).

Research on the effectiveness of homework and achievement in the technical sciences yielded disparate results in large-scale studies. An international study by Postlethwaite and Wiley (1992) found extensive homework times in science, where science achievement is high for secondary school students in the Netherlands. A national longitudinal study by Brandsma and Van der Werf (1997) found a small correlation between mathematics homework and mathematics achievement whereas research conducted by DeJong, Westerhof and Creemers (2000) evinced a general lack of policy on mathematics homework in 28 Dutch schools and that frequency of homework and out of school study time were not related to mathematics achievement.

Another focus of the study were attitude in mathematics and self-concept in mathematics. Researchers have long acknowledged the relationship between self-concept and achievement (Byrne, 1986; Fennema, 2000; Taylor & Michael, 1991). Similarly, students who like mathematics are more likely to persist in mathematics (Gwizdala & Steinback, 1990) and this perseverance is directly correlated to achievement (Dweck, 1986; Steinberg, Brown & Dornbusch, 1996; Walberg, Fraser, & Welch, 1986). Dweck (1986) found that successful students persisted in mathematics and share common traits, most notably personal accountability, whereas lower achieving students view their mathematical ability as fixed.

This is of critical importance to researchers as female students, from the onset of elementary school, exhibit lower confidence in their mathematical ability and lower performance expectation than their counterparts (Ethington, 1992; Siegle & Reis, 1998; Stipek & Granlinski, 1991; Vermeer, Boekaerts, & Seegers, 2000) even though there are no significant differences by gender on mathematics achievement at the elementary level (Friedman, 1995; Marsh, Smith, & Barns, 1985). Low performance by female students on complex problem solving tasks in the Netherlands led researchers (Lester & Garofalo, 1987) to conclude that attitude and confidence in one's own mathematical abilities may significantly affect one's ability to successfully complete problem solving tasks.

Research shows (Tirri, 2002; Feng, Campbell, & Verna, 2002) that positive student-teacher relationships affect high achievement. Schiering & Dunn (2002) found that teacher support through student empowerment strategies elevated student attitudes towards learning and increased their level of achievement. Wentzel and Battle (2001) purport that high student achievement was related to the students' successful adjustment in school and whether they perceived their teachers as supportive and not overly demanding. Results from a Finnish study (Lahelma, 2000) suggest that students value teachers who they perceive as friendly, sensitive, and impartial and can maintain classroom discipline. Tirri (2001) found that both male and female math, physics, and chemistry Olympians credit their teacher's encouragement as critical to their talent development.

A final focus of this study was gender inequities in the parent-based disciplines, specifically mathematics. Although diversified explanations exist for this global phenomenon, most researchers acknowledged socialization factors (Campbell, 1994; Cho, 2001; Eccles, 1982; Lubinski, Benbow, & Morelock, 2000; Tirri, 2001). Campbell's (1994) differential socialization paradigm is a framework comprised of 325 socio-psychological variables and used for understanding the complexities that underlie gender inequity. Campbell maintains that these socio-psychological variables are reinforced over time by parents, teachers, and peers through various family processes, attributions, self-concepts, and school related variables to eventually produce observable gender gaps and gender stereotypes.

The existence of gender gaps in mathematics on a global perspective is not new (Cho, 2001; Campbell, 2002; Kerr, 2000; Lengfelder, & Heller, 2001; Linn & Hyde, 1989; Lubinski, & Benbow, 1992). Research concurs (Campbell & Beaudry, 1998; Dweck, 2002; Eccles-Parsons, 1984; Lubinski, Benbow, & Morelock, 2000) that gender differences become apparent at the secondary level when female students begin to exhibit less confidence mathematically, are less inclined to enroll in higher level mathematics courses and perform lower than males on problem solving and higher level mathematics tasks.

The purpose of this study was to examine the linkages between perceived student ability and self-concept in mathematics, and various parental and pedagogical factors that lead to high mathematics achievement for both male and female secondary students in the top three European countries of the TIMSS-R 1999 Study.

### **Limitations**

Although this study was based on a large sample of international eighth grade students and is intended to represent the population of students from Belgium-Flemish, Netherlands, and Slovakia who were in the eighth grade in 1999, there are several limitations. Sources of potential bias include the accuracy of self-reported questionnaires, language conversion of the English-based survey, including the opportunity to modify wording consistent with the country's national system (Gonzalez & Miles, 2001), and exclusion of students with limited proficiency in their native language, and/or are emotionally, educationally, or physically disabled.

In order to be able to generalize the sample data to the targeted eighth grade population, the TIMSS 1999 data has been weighted according to the TIMSS 1999 User's Manual (Gonzalez & Miles, 2001). The weighting factors adjust the data to compensate for the unequal probability of selection of the sample and to reduce the bias caused by student (unit) non-response. There is no adjustment available to compensate for the bias introduced by sector (disabled students, non-language proficient students) under-representation (Foy & Joncas, 2000).

In addition, the means used by TIMSS 1999 to measure overall mathematics ability, although efficient and reliable for measuring population characteristics, results in a loss of information with respect to individuals, and could be a source of bias (Wingersky, Kaplan, & Beaton, 1987). The possible bias introduced by using aggregate methods of measuring achievement was statistically controlled by

imputing missing information and generating plausible value scores (Gonzales & Miles, 2001). The plausible value scores for overall mathematics achievement were used in this study.

The complicated sample design used in TIMSS does not meet the assumptions needed for making inferences from standard, parametric, statistical procedures. The IEA statistically controlled for design effect by using a jackknife repeated replication method which provides approximately unbiased estimates of sampling error (Gonzales & Miles, 2001). The appropriate Jackknife procedures were used in this study. Since regression methods were applied and plausible values in mathematics served as the dependent variable, analyses were done using the JACKREGP.SPS macro to compute weighted regression coefficients and adjusted standard errors in accordance with the instructions in the TIMSS 1999 User Guide (Gonzalez & Miles, 2001).

## **METHODS**

The Third International Mathematics and Science Study-Repeat (NCES, 1999), conducted by the International Association for the Evaluation of Educational Achievement (IEA), supplied the data for this study. This international study provided background and achievement data for eighth grade students from 27 different nations, background information from their mathematics teachers, and from their school principals.

### **Sample**

Student data files were extracted from the top three European scoring countries in mathematics: 5 258 from Belgium-Flemish, 2 961 from the Netherlands, and 3 497 from the Slovak Republic eliciting a cumulative sample size of approximately 12 000.

### **Instrumentation**

The programmers of the 1999 TIMSS-R Study developed background questionnaires that examined all possible factors which lead to student achievement in the technical sciences (Gonzalez & Miles, 2001). Two sets of student questionnaires were prepared, one for schools which taught an integrated science curriculum and another for schools with a segregated science curriculum. Mathematics and home questions were identical on each.

The instruments were formulated in English and translated into the language of the country being measured. Cultural modifications were made to the questions, following explicit guidelines. Multiple independent translations and back translations were made to ensure consistency across the questionnaires. Statistical tests were done to detect items that were not comparable across nations (Gonzalez & Miles, 2001).

The mathematics test was comprised of 162 items, one-third of which were identical to the test administered to the eighth grade in TIMSS (1995). The remaining questions were new to the 1999 study. Care was used to develop questions that were similar in content format and difficulty to the ones replaced. The questions tested

five curricular topics: fractions and number sense; measurement; data representation, analysis and probability; geometry; and algebra.

The 162 questions were distributed among eight versions of the test. Each student was randomly assigned one version and was asked to complete the questions. One-third of the questions were free response and were graded according to a detailed rubric. Item response theory (IRT), which allows reliable scores to be attained when many students answer few questions, was used in the TIMSS 1999 study. The National Research Coordinator (NRC) from each country was responsible for overseeing testing within their schools and insuring compliance with the standardized procedures.

### **Variable Selection**

This study utilized six derived variables, representing 19 source variables, from the TIMSS 1999 data. Each of these derived variables was formed by merging and rescaling source variables within the student questionnaires (Gonzalez & Miles, 2001). These particular predictor variables were chosen by the authors for two reasons: their attributes fit the logical time frame of student growth and achievement and the authors are conducting similar studies with different countries from the TIMSS-R Database. In addition, variables used to measure similar constructs by other researchers (Campbell, 1994; O'Connor & Miranda, 2002) served as a guide to the current selection. All variables chosen originated from the Student Background Questionnaires (TIMSS 1999 User Guide, Supplement) and from the mathematics achievement tests. In this study only the general form of the student questionnaire was utilized, since all five countries taught an integrated science curriculum.

The overall plausible scores from the Mathematics Achievement tests served as the dependent variable. The authors' decision to use the combined scales was based on the purpose of the study and the increased reliability attained by IEA in computing combined scores. As suggested by the TIMSS 1999 users manual, all five plausible scores (BSMMAT01 – BSMMAT05), representing the National Council of Teachers of Mathematics (2000) content standards of "Data Representation, Analysis and Probability, Algebra, Fractions and Number Sense, Geometry, and Measurement" were used in the study to measure mathematics achievement.

It was assumed that demographic variables occur at the onset of the educational continuum. The derived variables BSDGHERI and BSDGPSA represent students' access to educational resources and diversified educational aids within the home. Home resources include number of books, educational aids, and level of parental education. Educational aids specify students' access to or ownership of dictionaries, study tables, and computers within the home. The predictor BSDGHERI also includes information on parents' level of education. Similarly, the issue of multicollinearity for the aforementioned predictors will be addressed within the discussion section as BSDGHERI includes BSDGPSA.

Students' perceptions on hours spent each day studying or doing homework in any subject outside of class was measured by the variable BSDGOSTI. To focus specifically upon hours spent studying mathematics or doing mathematics each day,

the predictor BSDMDAY7 was selected. Again the issue of multicollinearity for these predictors will be addressed within the discussion section, as BSDGOSTI includes BSDMDAY7.

Student attitude and self-concept in mathematics were measured by derived variables that utilized indices. Positive attitude in mathematics was measured by the variable BSDMPATM and represented an index of overall attitudes, ranging from most negative to most positive. Self-concept in mathematics was measured by the predictor BSDMCMAI was based upon a four-point Likert scale ranging from strongly agree to strongly disagree.

The following classification variables, IDCNTRY, IDGRADER, and ITSEX, were used to identify country, grade, and gender of the student. Similarly, the variables JKZONE and JKREP were used for sampling information and the variable TOTWGT for sampling weight.

### **Statistical Analyses**

Data were analyzed through Statistical Package of Social Science (SPSS) program, v. 12.0. and invocation of the JACKREGP macro created by the programmers at the International Association for the Evaluation of Educational Achievement (IAE) . The JACKREGP.SPS macro was used in order to determine each predictor's contribution to the criterion for each country The syntax file was created from the control file BSASCRM. Based upon the theoretical framework of this study, six derived variables, representing 19 source variables, were chosen from the TIMSS 1999 data. All variables chosen originated from the Student and Teacher Background Questionnaires (TIMSS 1999 User Guide, Supplements 1 and 3) and from the mathematics achievement tests. The overall plausible scores from the mathematics achievement tests served as the dependent variable.

Utilizing the JACKREGP.SPS macro, six separate regressions were run to reflect the unique contribution (R<sup>2</sup>) of each predictor variable. The data were sorted by country and by gender. The chosen predictor variables were entered into regression analyses using Campbell's (1997) guidelines of chronology, logic, and research. The order of the predictor variables were BSDGHERI, BSDGPSA, BSDGOSTI, BSDMDAY7, BSDMPATM, and BSDMCMAI. After the initial regression was run, the macro was called five additional times for analyses for each independent variable. The coefficient of determination (R<sup>2</sup>) was determined statistically significant if its calculated t-value had a probability less than 0.05 and was greater than the Bonferroni critical value of 2.39. As recommended in the TIMSS User Manual (Gonzalez & Miles, 2001), the Dunn-Bonferroni procedure was used to correct for the increased probability of a Type I error when comparing simultaneous comparisons. See Tables 1-6 for regression statistics using the macro JACKREGP.SPS for selected predictor variables for the three top scoring European countries of the 1999 TIMSS-R Database.



*Table 1: Regression Statistics for Predictor BSDGHERI (General Index of Home Educational Resources). Using the Macro JACKREGP.SPS*

Country	Gender	N	R <sup>2</sup>	Beta	Beta <sub>SE</sub>	* Sig.
Belgium-Flemish 956	Female	2622	5.8%	50.39	9.05	*5.57
	Male	2595	7.5%	54.17	12.73	*4.26
Netherlands 528	Female	1483	4.3%	46.41	12.14	*3.82
	Male	1396	2.2%	33.02	7.27	*4.54
Slovakia 703	Female	1789	9.4%	59.29	6.47	*9.16
	Male	1684	7.9%	58.76	4.96	*11.85

P II .05

*Table 2: Regression Statistics for Predictor BSDGPSA (Generally Possess Educational Aids in the Home) using the macro JACKREGP.SPS*

Country	Gender	N	R <sup>2</sup>	Beta	Beta <sub>SE</sub>	* Sig.
Belgium-Flemish 956	Female	2619	3.0%	-34.07	8.91	*-3.82
	Male	2586	9.0%	-58.34	13.41	*-4.35
Netherlands 528	Female	1483	1.0%	-34.84	9.67	*-3.60
	Male	1396	1.0%	-30.87	8.71	*-3.54
Slovakia 703	Female	1779	6.0%	-36.35	4.94	*-7.36
	Male	1674	4.0%	-30.34	4.96	*-6.12

P II .05

*Table 3: Regression Statistics for Predictor BSDGOSTI (General Out-of-School Study Time) using the macro JACKREGP.SPS*

Country	Gender	N	R <sup>2</sup>	Beta	Beta <sub>SE</sub>	* Sig.
Belgium-Flemish 956	Female	2411	0.0%	- 7.61	5.27	
	Male	2450	0.0%	6.40	6.17	
Netherlands 528	Female	1464	2.0%	-19.43	9.22	
	Male	1377	0.0%	- 3.06	9.44	
Slovakia 703	Female	1731	1.0%	- 9.13	3.54	*-2.58
	Male	1634	1.0 %	-11.20	3.80	*-2.95

P II .05

*Table 4: Regression Statistics for Predictor BSDMAY7 (Hours Spent Each Day Studying Math). Using the Macro JACKREGP.SPS*

<i>Country</i>	<i>Gender</i>	<i>N</i>	<i>R<sup>2</sup></i>	<i>Beta</i>	<i>Beta<sub>SE</sub></i>	<i>* Sig.</i>
Belgium-Flemish (956)	Female	2615	4.0%	-14.86	2.86	*-5.20
	Male	2582	0.0%	- .34	3.24	
Netherlands (528)	Female	1476	3.0%	-22.17	15.47	
	Male	1396	1.0%	-18.17	8.88	
Slovakia (703)	Female	1774	2.0%	-12.63	2.04	*-6.19
	Male	1664	2.0%	-20.14	3.61	*-5.58

P II .001

*Table 5: Regression Statistics for Predictor BSDMPATM (Index of Student's Positive Attitude Towards Mathematics). Using the Macro JACKREGP.SPS*

<i>Country</i>	<i>Gender</i>	<i>N</i>	<i>R<sup>2</sup></i>	<i>Beta</i>	<i>Beta<sub>SE</sub></i>	<i>* Sig.</i>
Belgium-Flemish (956)	Female	2610	12.0%	36.49	3.65	*10.00
	Male	2578	12.0%	39.15	4.34	* 9.02
Netherlands (528)	Female	1442	2.0%	16.19	6.72	* 2.41
	Male	1360	2.0%	17.20	4.42	* 3.90
Slovakia (703)	Female	1775	5.0%	27.60	3.46	* 7.98
	Male	1655	5.0%	29.53	4.52	* 6.53

P II .001

*Table 6: Regression Statistics for Predictor BSDCMAI (Index of Student's Self-Concept in Mathematics). Using the Macro JACKREGP.SPS*

<i>Country</i>	<i>Gender</i>	<i>N</i>	<i>R<sup>2</sup></i>	<i>Beta</i>	<i>Beta<sub>SE</sub></i>	<i>* Sig.</i>
Belgium-Flemish (956)	Female	2611	18.1%	50.19	4.44	*11.30
	Male	2574	11.0%	43.50	2.73	*15.93
Netherlands (528)	Female	1475	12.3%	46.83	5.97	* 7.84
	Male	1389	10.7%	42.89	6.18	* 6.94
Slovakia (703)	Female	1764	19.8%	52.16	2.99	*17.44
	Male	1647	19.2%	55.36	2.90	*19.09

P II .001

## RESULTS

Six separate regressions, using the JACKREGP.SPS macro, were run to reflect the unique contribution ( $R^2$ ) of each predictor variable. Tables 1 through 6 report the regression coefficients and coefficient of determination ( $R^2$ ) for each predictor variable.

Table 1 refers to the number of books in the home, educational aids in the home (computer, personal study desk, and dictionary) and parent's highest level of education being listed as the university. Both genders within all three countries report significance, with coefficients of determination ranging from 2.2% to 7.9%.

Table 2 refers specifically to the aforementioned educational aids in the home: computer, personal study desk. The results of Table 2 show negative significance by both genders within all three countries. Both genders in the Netherlands report extremely small significance, while both males and females in Belgium-Flemish and Slovakia show coefficients of determination ranging from 3.0% to 9.0%.

Table 3 reports hours spent each day studying or doing mathematics, science, and/or other school subjects other than mathematics and science. Both genders within Slovakia, report extremely small negative significance. Out of school study time was not a predictor for both genders in Belgium-Flemish and the Netherlands.

Table 4 refers specifically to hours spent each day studying mathematics or doing homework in mathematics. Both genders in Slovakia and females in Belgium-Flemish report small negative significance, with coefficients of determination ranging from 2.0% to 4.0%. Hours spent each day studying or completing homework in mathematics was not a predictor for Belgium-Flemish males.

Table 5 is an index of the students' attitude towards mathematics (including relevance of mathematics and pursuing a job that involved mathematics), with coefficients of determination ranging from 2.0% to 12.0%.

Table 6 is an index of the students' self-concept in mathematics and is the strongest predictor for both genders in all three countries with the coefficients of determination ranging from 10.7% to 19.8%.

## DISCUSSION

Concurring with prior research, the strongest predictor for high mathematics achievement for both genders in all three countries was the students' self-concept in mathematics. Additional significant positive predictors for both males and females in all three countries include a positive attitude towards mathematics and home educational resources, which includes parents' educational level. Pedagogical and parental factors were also key influences to high mathematics achievement. Majority of the students reported that at least one of their parents attended and/or completed a university program and they had an ample supply of books in their home. In addition, their teachers stressed critical thinking and problem solving skills in the classroom.

Both genders within all three countries evinced negative significance with respect

to owning or having access to all three educational aids (a computer, a personal study desk, and a dictionary) in their home. This result implies that students are missing at least one or more of the aforementioned study aids in their home. However, an issue of multicollinearity exists with the educational resource variables, BSDGHERI and BSDGPSA, as these composite predictors include the same source variable [SQ2-11b, c, d] that refers to students' access to or ownership of dictionaries, study tables, and computers within the home. In addition, general outside study time was not significant for both genders in Belgium-Flemish and the Netherlands and negatively significant (very small) for males and female students in Slovakia.

Student perceptions on hours spent studying mathematics or doing math homework were not significant for both genders in the Netherlands and male students in Belgium-Flemish; however, both genders in Slovakia and female students in Belgium-Flemish evinced negative significance, which implies that these students do not complete tasks involving their mathematical assignments outside of school. One probable explanation for mathematics homework not being completed at home is that high achieving students are capable of completing their homework in less time than lower achieving students and/or they might have the opportunity to complete their homework while still at school.

Although negligible differences were found by gender within all three countries on the mathematics achievement tests, the number of females entering the university and majoring in mathematics is low and in sharp contrast to males. This is of particular significance to all nations as a dearth of female mathematicians and scientists exists worldwide. The results of this study clearly suggest that educational leaders and parents should address "alternate measures" to reduce gender stereotyping and build gender equity in the hard sciences, as these gaps remain unchanged despite efforts to eliminate them in Europe, Asia, and America.

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